

Contrasting growth response of jack pine and trembling aspen to climate warming in Quebec mixedwoods forests of eastern Canada



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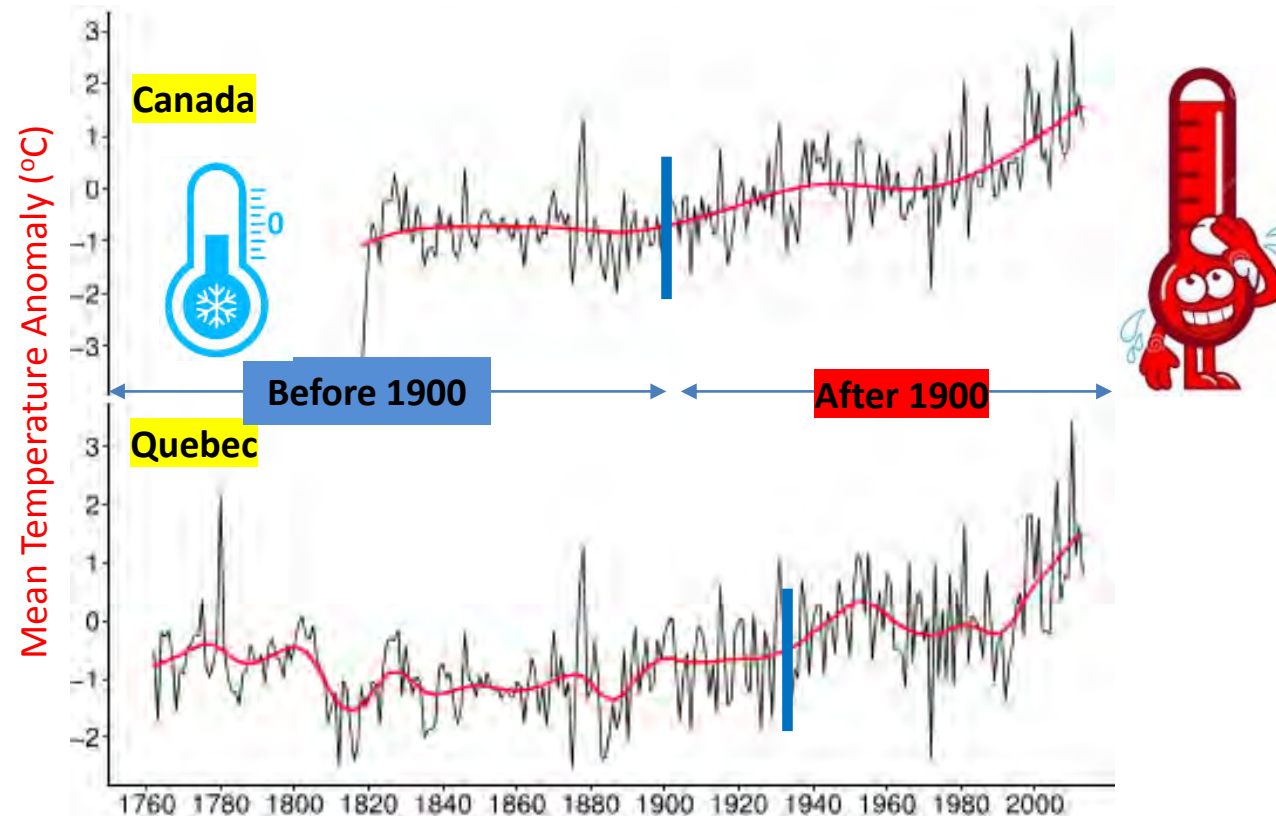
Prof. Martin GIRARDIN (NRC-CFS)

Outline

- Research problem
- General objective & hypothesis
- Methodology
- Results & discussion
- Conclusions

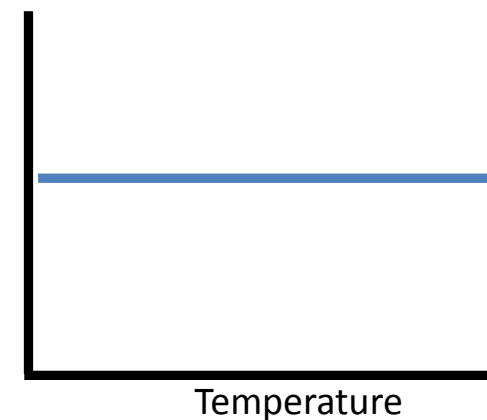
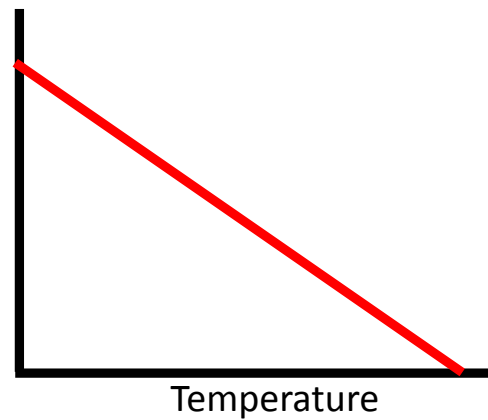
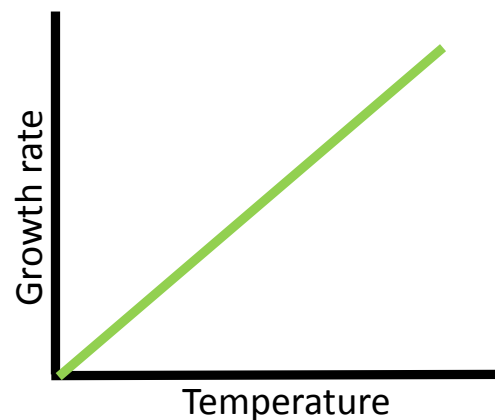
Climate warming is impacting on boreal and temperate forests, where trees growth are limited by cold temperatures and short growing season.

(Girardin et al., 2013; Buermann et al., 2013; 2014)



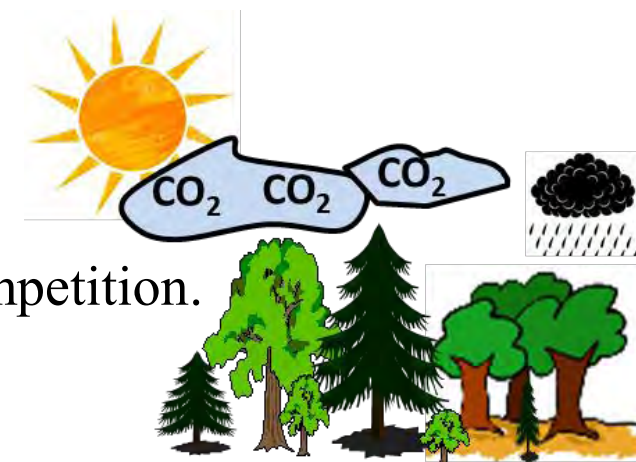
Source of data: Berkeley Earth, 2019

Research shows both **positive** and **negative** effects of the climate warming on trees growth. In some instances **NO effect**.



Causes of differences among studies:

- Species identity: e.g. conifer versus deciduous
- Site conditions e.g. topography, soil moisture availability, inter-tree competition.
- Field sampling deficiencies and analytical procedures.



Objective

To assess the century-long trends in the dynamics of growth rates of trembling aspen (*Populus tremuloides* Michx.) and jack pine (*Pinus banksiana* Lambert) that had recruited during the 19th and 20th centuries.

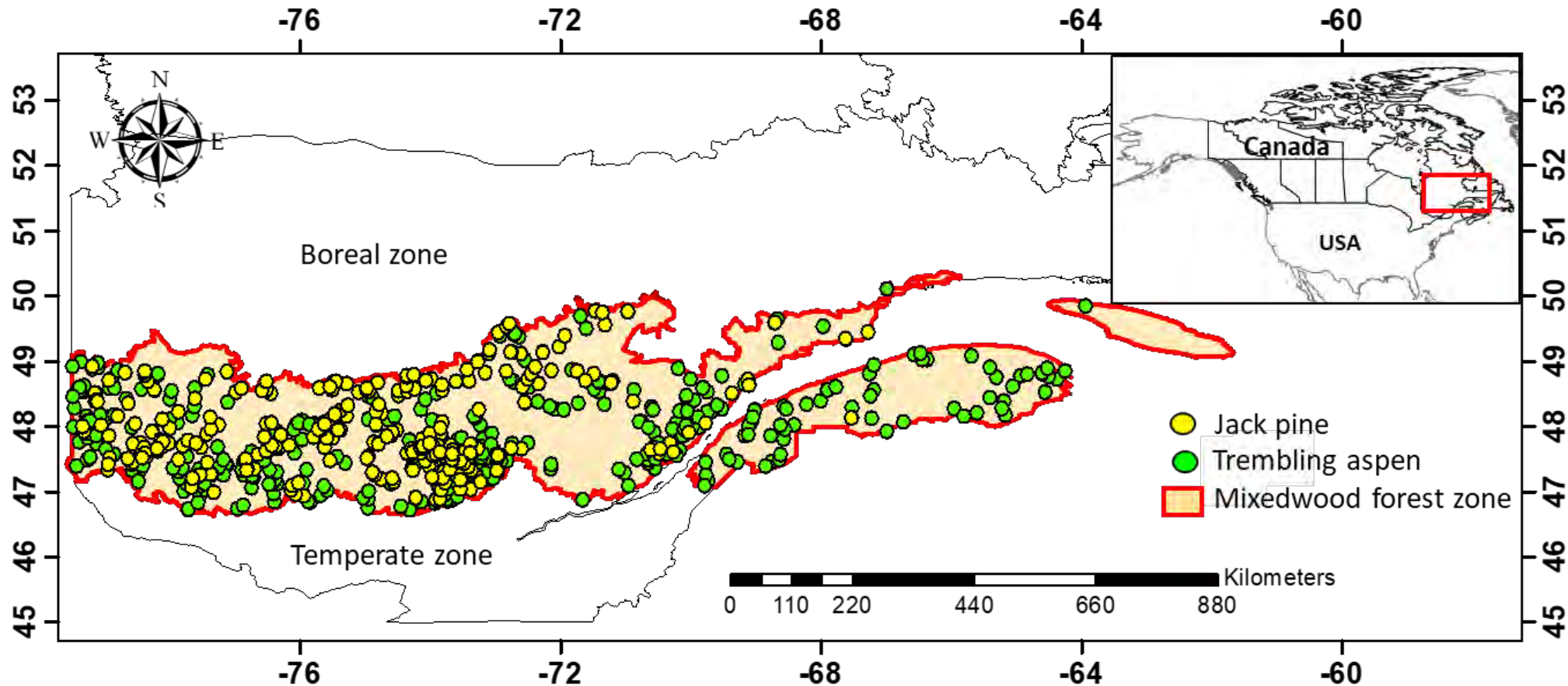


Hypotheses tested:

(H1) the growth rates of jack pine and trembling aspen increased since 19th century till the late 20th century.

(H2) stand conditions (e.g. terrain slope, inter-tree competition, soil moisture, temperature etc.) modify the long-term trends in growth.

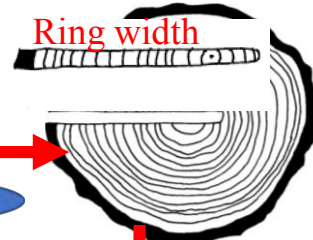
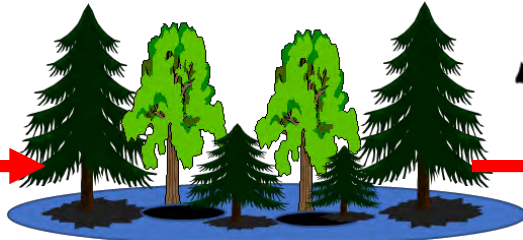
- **Study area:** Mixedwood forest zone of Quebec (Canada)
- **Source of data:** Quebec 's Ministère des Forêts, de la Faune et des Parcs (MFFP) forest inventory data
- **Focus:** Shade intolerant tree species: Conifer jack pine and broadleaf trembling aspen.



Stratified sampling of plots



Plots



Basal area increment,
BAI ($\text{cm}^2 \text{year}^{-1}$)

Site variables

Inter-tree competition, CI (m^2ha^{-1})
Terrain slope (%)
Climate Moisture Index, CMI (mm)
Maximum temperature, TMax ($^{\circ}\text{C}$)
Soil type

Non-linear mixed effort model (GAMM)

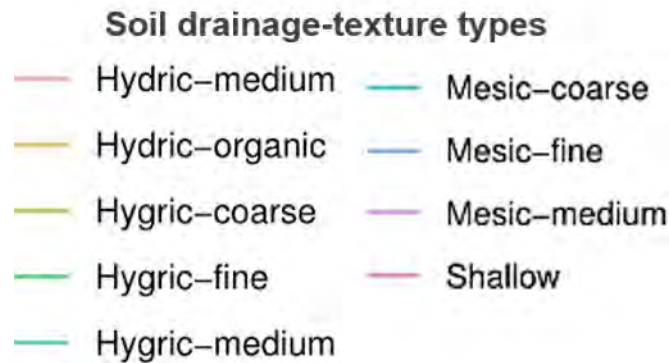
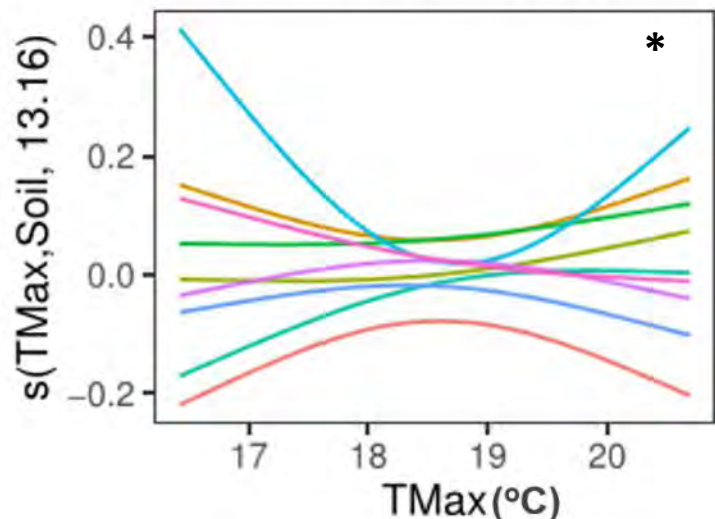
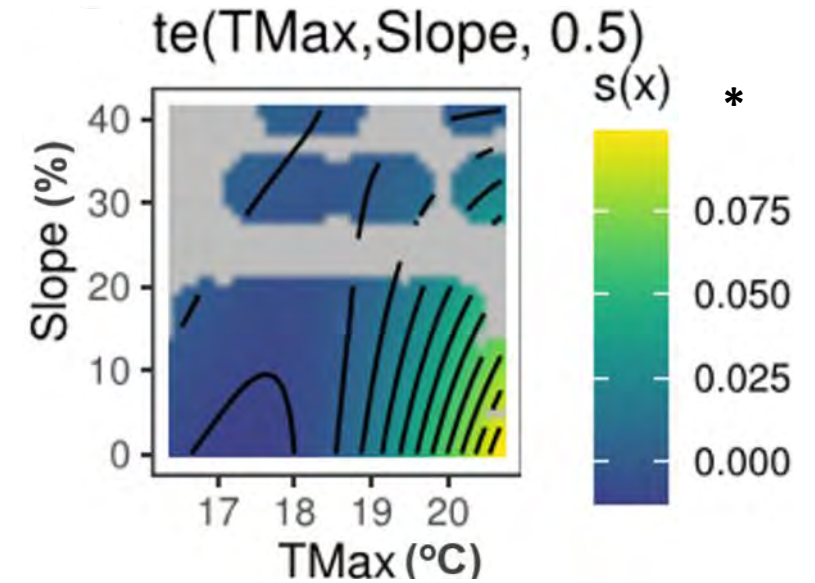
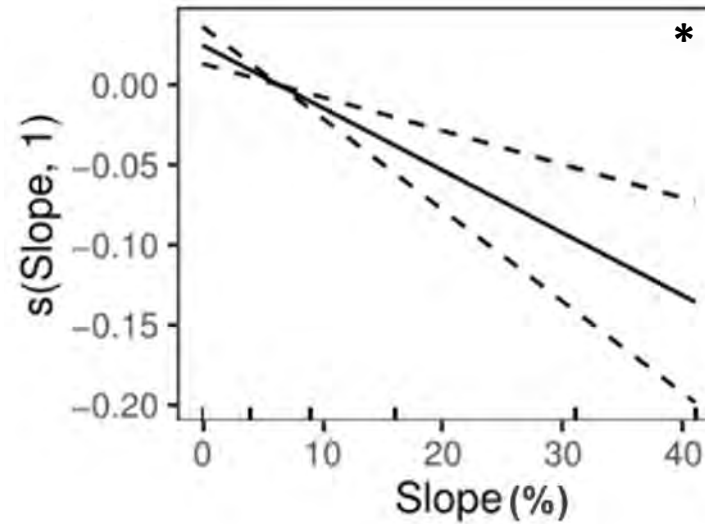
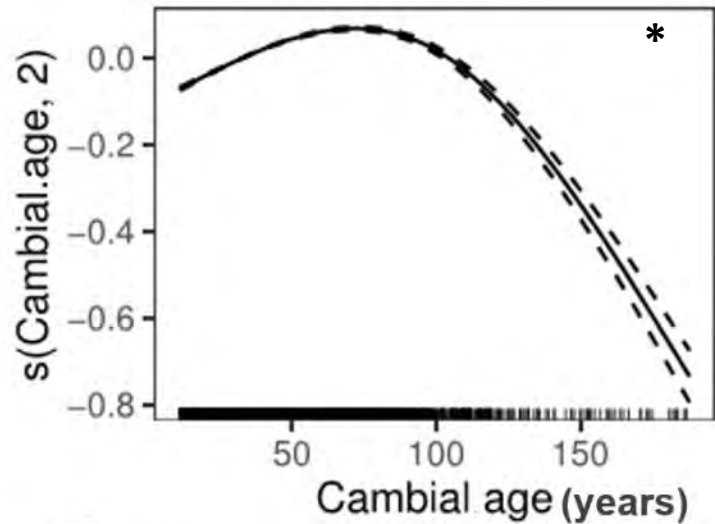
BAI = tree size + cambial age + competition index + terrain slope + soil type + maximum temperature + climate moisture index + interactions among variables + random effect of trees

Weighted the difference between observed (O) BAI (OBAI, cm^2) and predicted (P) BAI (PBAI, cm^2) by the PBAI and expressed it as percentage (GC %):

$$\text{GC} = \frac{\text{OBAI}_{jkt} - \text{PBAI}_{jkt}}{\text{PBAI}_{jkt}} \times 100$$

Jack pine

- Relationship between tree growth rate and stand and environmental variables*

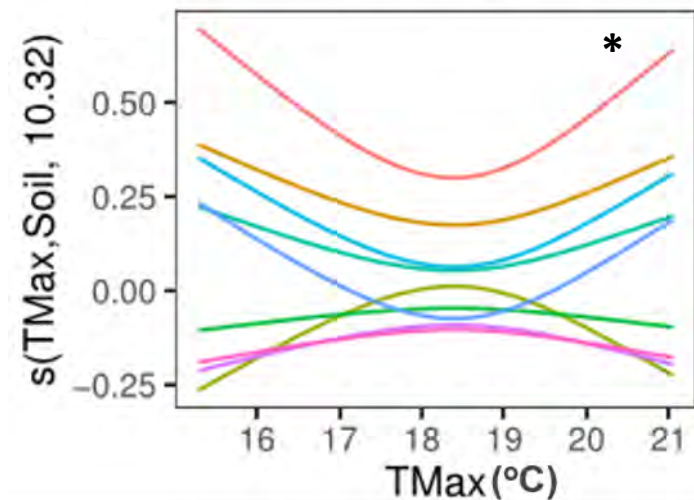
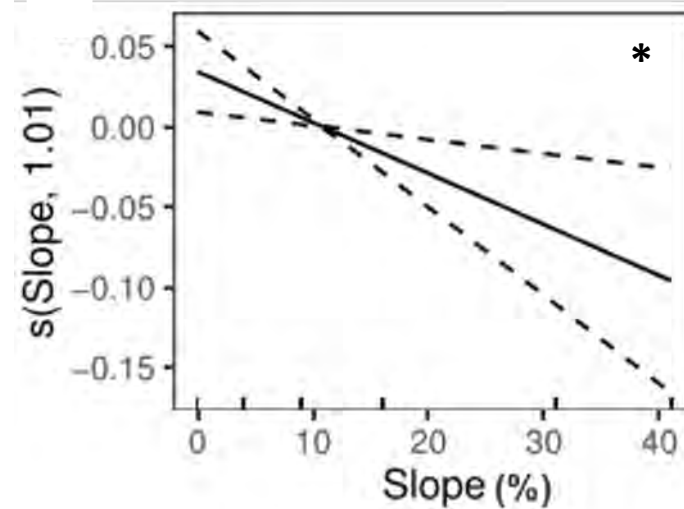
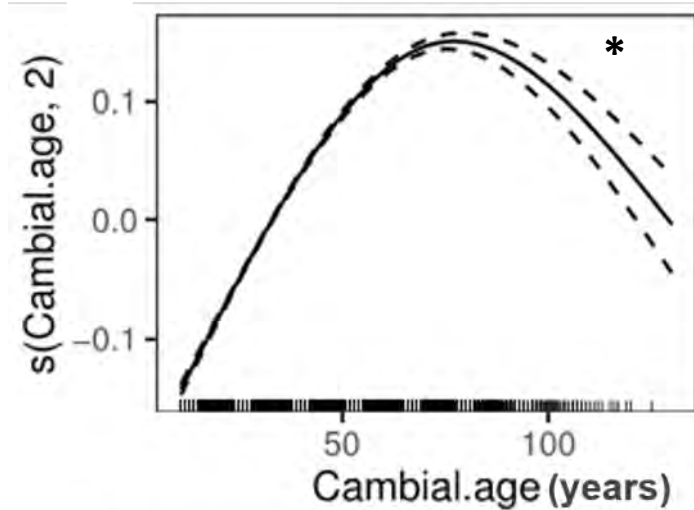


* Significant at $P < 0.05$

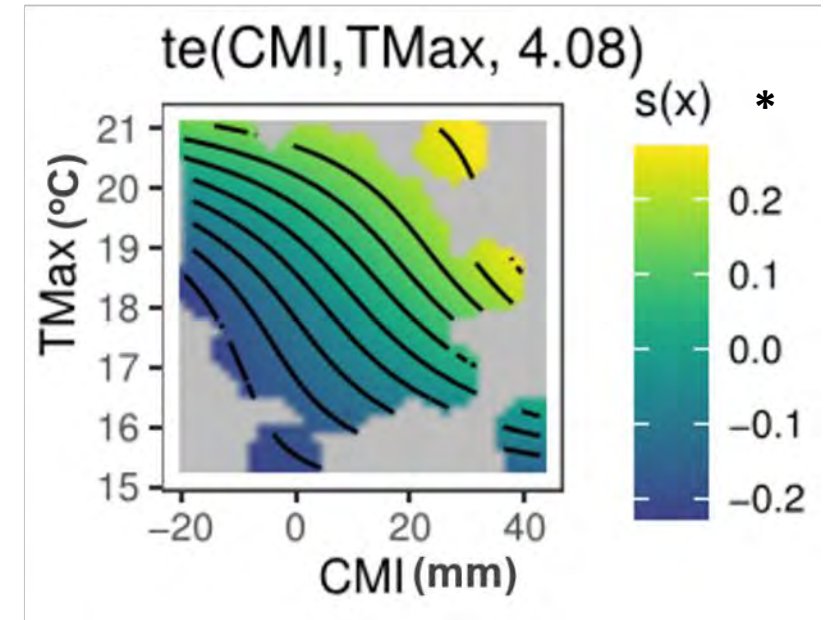
- In the plots, OX-axis represents a covariate, while the OY-axis represents effect values.
- Contours shows transition bands of interactive effects of factors.
- Dash lines on effect plots denote the 95% confidence intervals.

Trembling aspen

- Relationship between tree growth rate and stand and environmental variables



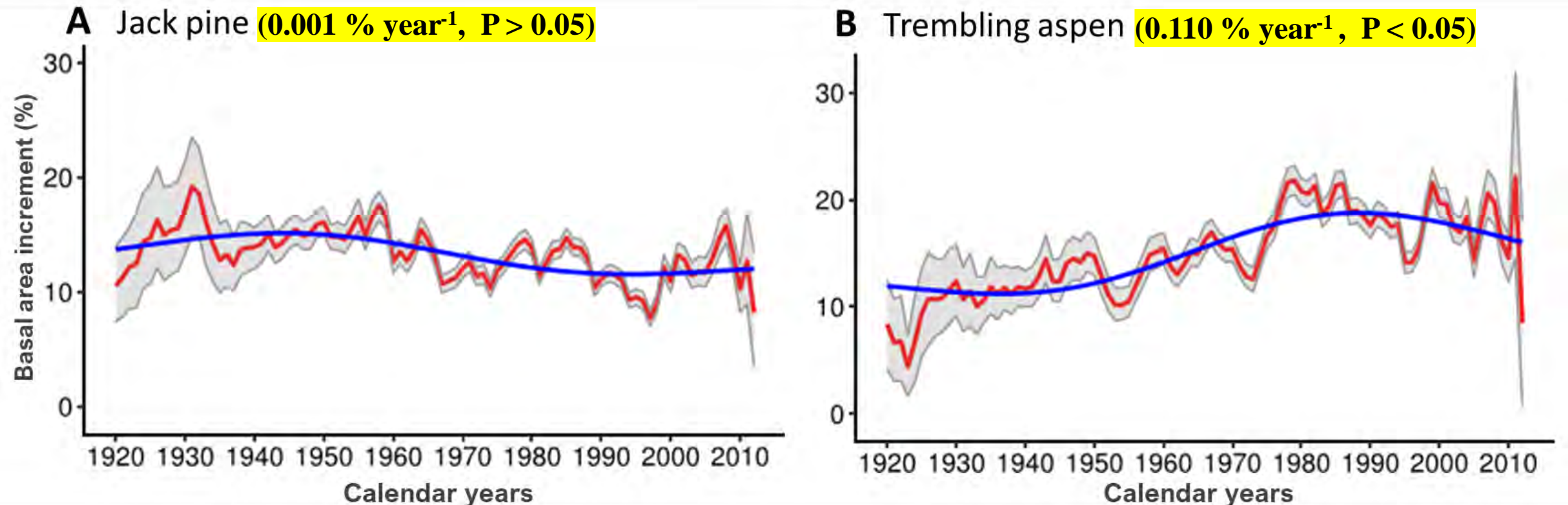
* Significant at $P < 0.05$



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Long-term growth variability

- A significant increase in the radial growth rate of trembling aspen, whereas that of jack pine showed no significant long-term trend between the period 1950 and 2012.



(Values in parenthesis are regression slopes computed over the period 1950 and 2012)

- Growth responses of trees to climate warming may be species-specific in the boreal mixedwood.
- Because of the variability in site conditions, the trees growth response to the climate will be variable across the boreal region.
- Managers should be cautious in generalizing management prescription. Instead we should encourage them to take into consideration species-specific growth trend patterns in long-term planning.
- It remains to be known how species-specific growth response to climate will influence the future composition of the boreal mixedwood.

THANK YOU

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